Hydrogenated TiO$_2$ Thin Film for Accelerating Electron Transportation in Planar Perovskite Solar Cells

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Abstract

Intensive research on low-temperature deposited electron transport materials has been pursued to improve the efficiency of n-i-p type planar perovskite solar cells and expand their application on plastic and multijunction device architectures. Here, a TiO$_2$ film with enhanced conductivity prepared by magnetron sputtering at room temperature with hydrogen doping (HTO) is developed to accelerate the electron extraction from perovskite photoabsorber and reduce charge transfer resistance, resulting in an increased short circuit current density and fill factor. The HTO film with shifted higher fermi level guarantees a smaller loss on $V_{OC}$ and facilitates the growth of high-quality absorber, resulting in devices with negligible hysteresis. In comparison with the pristine TiO$_2$ prepared without hydrogen doping, the HTO-based device exhibits a substantial power enhancement with a 19.30% efficiency and the photovoltaic performance maintains 93% of its initial power conversion efficiency after 300 minutes’ continuous illumination in the glove box. These properties make the room-temperature magnetron sputtered HTO film a promising electron transport material for perovskite solar cell application in flexible and tandem devices in the future.

Keywords: planar perovskite solar cells, hydrogen doping, faster electron transport layer, reduced transfer resistance